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Clayton
GROUP SERVICES

MEMORANDUM

To: Steve Faryan, Stan Komperda

cc: Howard Chinn

From: Jeff Pope

Subject: Results of SVE and ERH Blower Tests at Lockformer

Date: January 29, 2004

In response to discussions during the last biweekly agency meeting, Clayton prepared a test plan and conducted testing of the SVE blowers assisting the ERH vapor recovery system. Several tests were conducted to determine if the existing SVE blowers could provide added vacuum and/or airflow for the ERH vapor recovery operations. The testing was conducted on Thursday, January 22, 2004.

A series of three tests were conducted with the SVE and ERH Systems. Brief explanations of the tests are as follows:

Test No. 1 - SVE Blower #1 was used to pull air from both the SVE well network (i.e., VE-1 through VE-48) and from the ERH vapor recovery system. The water knockout tank and ERH flow meter were taken out of service by closing the inlet valve and opening the ERH bypass valve inside the remediation building. The air dilution valve on SVE #1 was closed completely. The air dilution valve on the ERH blower was closed as it has been for the last 6 months of operation. This configuration allowed some airflow from the SVE wells and all of the ERH vapor recovery air to flow through SVE #1. Readings were taken from various locations (as identified in the attached test plan).

Test No. 2 – The SVE well network was closed and SVE Blower #1 was used to pull air from the ERH vapor recovery system only. This was a theoretical test to determine the maximum assistance to be provided by the SVE blower, but could not be implemented since the SVE wells were not online. The air dilution valve for SVE Blower #1 was completely shut during the test. The air dilution valve on the ERH blower was closed as it has been for the last 6 months of operation. Test 2A was conducted after completing the original test by opening the SVE Blower #1 air dilution valve in order to reduce the vacuum and amperage loading on the blower motor.

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MEMORANDUM
(Continued)

Test No. 3 – The same configuration with SVE Blower #1 and ERH blower (i.e., in series) as in Test 2A (air dilution valve slightly open) with the addition of SVE Blower #2 to extract air from the SVE well network only. Test 3A was conducted to reduce vacuums in an effort to find a point at which both the vacuum was acceptable and the amperage load on the SVE blower motors was in a normal operating range.

Prior to conducting the tests, baseline readings were obtained from both systems as they are currently configured. This information was used as a comparison for the results of the aforementioned tests.

RESULTS

Test No. 1

Test No. 1 began at 13:32 and was completed at 14:12. Tables 1 through 3 show the measurements taken at each test parameter throughout the test (attached). The reconfiguration reduced the total flow due primarily to the shutting of the SVE Blower #1 air dilution valve. The SVE Blower #1 inlet flow increased due to introduction of the ERH system air effluent. The overall discharge airflow from SVE Blower #1 was unchanged due to the closing of the air dilution valve. Unfortunately, this configuration reduced the overall flow and vacuum from the SVE wells since the discharge pressure from the ERH blower reduced the vacuum at the SVE Blower #1 inlet. Vapor phase carbon inlet, intermediate, and stack pressures decreased due to the reduction in overall airflow from the systems.

The airflow from the ERH system dropped by about 30% with this configuration based on readings taken at the ERH blower. No change in the ERH system vacuum at the blower was observed.

Test No. 2

Test No. 2 began at 14:12 and was completed at 14:40. Tables 1 through 3 show the measurements taken at each test parameter throughout the test (attached). This test was conducted to determine the theoretical maximum additional flow rate gain on the ERH system. However, this configuration would not be able to be implemented since the SVE wells were not in operation.

During this test, the inlet vacuum on SVE #1 exceeded 100 inches of water and the discharge temperature on the blower rose to approximately 147 °F from 80 °F. Although the heat exchanger on the discharge side of SVE #1 was working well to reduce the temperature, the test was suspended due to the high increase in discharge temperature. The airflow through SVE #1 reduced to about 1,100 scfm during the test and the motor amperage increased to over 49 amps (the expected operating range for the 40 Hp motor is about 40 to 45 amps).

No increase in the vacuum was observed on the ERH vapor recovery system. Reading on the ERH system indicated an approximate increase of 100 cfm and the venturi flow meters connected to the SVE PLC indicated a rise in airflow of about 300 cfm. However, the 300 cfm indicated increase compared with the 100 cfm increase measured at the ERH blower was due primarily to the temperature rise in the air stream.

Due to the unacceptable motor amperage on SVE Blower #1 encountered during the test, a modification of Test 2 was implemented as Test 2A.

Test No. 2A

In an effort to determine if a reasonable amperage load could create approximately the same system readings, the air dilution valve on SVE Blower #1 was opened. This allowed for the reduction in the inlet vacuum and subsequent reduction in blower motor amperage (down to 38.5 amps). Approximately 220 cfm of dilution was introduced and resulted in a vacuum of 69 inches of water. The air discharge temperature decreased to about 117 °F. The inlet airflow to SVE Blower #1 was approximately the same as during Test 2 (1,023 cfm versus 1,172 cfm for Test 2), with no increase in vacuum on the ERH vapor recovery system. Airflow at the ERH system was approximately the same as during Test 2 (660 cfm versus 630 cfm for Test 2). The ERH airflow increased approximately 130 cfm compared to the baseline airflow. However, this configuration could not be implemented since the SVE wells were not operational during this test.

Test No. 3

Test No. 3 began at 14:57 but was temporarily suspended due to belt slippage on SVE Blower #2. The belt was tightened and the test restarted at 15:15. The test was completed at 15:45 when SVE #1 tripped off due to high amperage. The air dilution valve on SVE Blower #1 was kept at the same opening as during Test 2A. The air dilution valve on SVE Blower #2 was closed to produce a vacuum on the SVE wells of about 24 inches of water.

SVE Blower #1 airflow was the same as Test 2 and 2A (1,009 cfm compared to 1,172 cfm and 1,023 cfm for Tests 2 and 2A, respectively). SVE Blower #2 added approximately 1,400 cfm of air to the overall discharge flow from the stack (970 cfm from the SVE wells and 430 cfm from dilution). Amperage load on SVE Blower #1 increased to over 50 with the amperage load on SVE Blower #2 at about 38 (normal operating range for this 30 Hp motor is 32-35 amps). No increase in ERH vapor recovery system vacuum was observed and an overall reduction in flow rate from the ERH system was observed (dropped from 530 cfm at baseline to 470 cfm during the test).

Test No. 3A

Due to the high amperage loads on both SVE Blower #1 and SVE Blower #2, this test was conducted to attempt to balance the vacuum on the SVE wells with the amperage load on both blowers. Unfortunately, the amperage load on the motors could not be reduced by more than about 1 amp be adjusting the air dilution valves on both SVE Blower #1 and SVE Blower #2. Vacuum to the SVE wells was reduced to about 16 inches, which is generally the lower limit for producing the design influence throughout the system. This adjustment also reduced the flow from the SVE wells from about 970 cfm to about 670 cfm. Airflow through SVE Blower #1 (all from the ERH vapor recovery system) was reduced to about 990 cfm. Airflow readings at the ERH system indicated an airflow increase of about 150 cfm. This was primarily due to the "bouncing" around of the anemometer used to measure the air velocity in the ERH piping. No increase in the ERH vacuum was observed during this test.

Following the conclusion of the above referenced tests, both the SVE and ERH systems were returned to the operating configuration identified as the baseline (i.e., SVE Blower #1 extracting from SVE system only and ERH blower extracting from vapor recovery system only).

CONCLUSIONS

The test results confirmed that the existing SVE blowers would not be able to provide a significant amount of additional airflow and/or vacuum to enhance performance of the ERH vapor recovery system. Intuitively, this seems to be correct due to the fact that both the SVE and ERH blowers are positive displacement blowers. A positive displacement blower will not allow more air to flow through it than its rated capacity, and the inlet vacuum cannot be changed based on a change in the discharge pressure (i.e., vacuum induced by another blower).

It is evident from the tests that the existing blowers operated in series will not provide added capacity to the ERH vapor recovery system. Extensive system repiping to allow either another ERH blower to be added in parallel or use one of the existing blowers in parallel operation would be necessary to increase the vacuum and flow capacity of the ERH system. The major disadvantage of the repiping would be the loss in remediation time during the reconfiguration. It is estimated that it would take at least 4 weeks to completed the piping reconfiguration and may require that the ERH be run for an additional period of time above this 4 weeks, based on the calculated required energy input into the subsurface, to make up for lost energy input during the excessive downtime.

The only positive results of the testing occurred when the SVE blowers were running at unacceptable amperage loads on the motors. This would substantially reduce the lifetime or uptime of the blowers to operate the SVE system. Based on the results of the tests, it is not recommended to operate the existing blowers in these configurations due to the potential damage to the motors and blowers.

At the present time, TRS is focusing much of the system capacity on those electrodes in Area 2 that previously failed in an effort to complete the remediation as soon as practical. The preliminary results from subareas 1G and 1H indicate the potential to reduce flow in portions of these areas in the next couple of weeks. Since it is anticipated that excess flow capacity could more easily be gained by the closing of various areas in the near future, efforts will be focused on optimizing the remediation in subareas 2B, 2C, 2D, 1G & 1H in order that the remainder of Area 1 can be brought online.

Proposed SVE/ERH Blower Tests

Lockformer – Lisle, Illinois

As a result of discussions on blower efficiency related to the ERH remediation during last weeks agency meeting, several tests will be conducted to determine if the existing SVE blowers can provide added vacuum and/or airflow for the ERH vapor recovery operations.

The tentative plan is to conduct these tests on Thursday afternoon (January 22, 2004) beginning at around 1:00 PM. The following briefly outlines the tests to be conducted:

1. SVE Blower #1 Assisting ERH Blower (repeat of previous test)

- ERH Blower on with no air dilution (current configuration)
- SVE Blower #1 extracting from SVE network and ERH bypass with no air dilution
- Conduct test for 1 to 2 hours
- Prior to test monitor for the following:
  - baseline vacuum and flow readings on ERH VR system manifolds
  - baseline vacuum readings on representative ERH electrodes
  - baseline vacuum and flow readings on SVE wells
  - baseline vacuum and air flow on SVE blower #1 inlet
  - baseline vacuum and air flow on ERH blower inlet
  - baseline pressure and air flow on SVE #1 blower effluent
  - baseline pressure and air flow on ERH Blower effluent
  - baseline pressure on primary and secondary vapor-phase carbon
  - baseline pressure on stack (following secondary VPGAC)
  - baseline air flow through the stack
  - baseline amperage load on SVE Blower #1 motor
  - baseline amperage load on ERH blower motor
  - inlet and outlet temperature on ERH and SVE blowers
- During the test monitor for the following:
  - vacuum and flow readings on ERH VR system manifolds
  - vacuum readings on representative ERH electrodes
  - vacuum and flow readings on SVE wells
  - vacuum and air flow on SVE blower #1 inlet
  - vacuum and air flow on ERH blower inlet
  - pressure and air flow on SVE #1 blower effluent
  - pressure and air flow on ERH Blower effluent
  - pressure on primary and secondary vapor-phase carbon
  - pressure on stack (following secondary VPGAC)
  - air flow through the stack
  - amperage load on SVE blower #1 motor
  - amperage load on ERH blower motor
  - temperature inlet and outlet on ERH/SVE blowers

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Proposed SVE/ERH Blower Tests

Lockformer – Lisle, Illinois

2. SVE Blower #1 Assisting ERH Blower (SVE wells offline)

- ERH Blower on with no air dilution (current configuration)
- SVE Blower #1 extracting from ERH bypass only with no air dilution
- Conduct test for 1 to 2 hours
- Prior to test monitor for the following:
  - baseline vacuum and flow readings on ERH VR system manifolds
  - baseline vacuum readings on representative ERH electrodes
  - baseline vacuum and flow readings on SVE wells
  - baseline vacuum and air flow on SVE blower #1 inlet
  - baseline vacuum and air flow on ERH blower inlet
  - baseline pressure and air flow on SVE #1 blower effluent
  - baseline pressure and air flow on ERH Blower effluent
  - baseline pressure on primary and secondary vapor-phase carbon
  - baseline pressure on stack (following secondary VPGAC)
  - baseline air flow through the stack
  - baseline amperage load on SVE Blower #1 motor
  - baseline amperage load on ERH blower motor
  - inlet and outlet temperature on ERH and SVE blowers

- During the test monitor for the following:
  - vacuum and flow readings on ERH VR system manifolds
  - vacuum readings on representative ERH electrodes
  - vacuum and air flow on SVE blower #1 inlet
  - vacuum and air flow on ERH blower inlet
  - pressure and air flow on SVE #1 blower effluent
  - pressure and air flow on ERH Blower effluent
  - pressure on primary and secondary vapor-phase carbon
  - pressure on stack (following secondary VPGAC)
  - air flow through the stack
  - amperage load on SVE blower #1 motor
  - amperage load on ERH blower motor
  - inlet and outlet temperature on ERH and SVE blowers

Proposed SVE/ERH Blower Tests

Lockformer – Lisle, Illinois

3. SVE Blower #1 Assisting ERH Blower, SVE Blower #2 on SVE Network

- ERH Blower on with no air dilution (current configuration)
- SVE Blower #1 extracting from ERH bypass only with no air dilution
- SVE Blower #2 extracting from SVE well network
- Conduct test for 1 to 2 hours
- Prior to test monitor for the following:
    - baseline vacuum and flow readings on ERH VR system manifolds
    - baseline vacuum readings on representative ERH electrodes
    - baseline vacuum and air flow on SVE blower #1 inlet
    - baseline vacuum and air flow on ERH blower inlet
    - baseline pressure and air flow on SVE #1 blower effluent
    - baseline pressure and air flow on ERH Blower effluent
    - baseline pressure on primary and secondary vapor-phase carbon
    - baseline pressure on stack (following secondary VPGAC)
    - baseline air flow through the stack
    - baseline amperage load on SVE Blower #1 motor
    - baseline amperage load on ERH blower motor
    - inlet and outlet temperature on ERH and SVE blowers

- During the test monitor for the following:
    - vacuum and flow readings on ERH VR system and electrodes
    - vacuum and air flow on SVE blower #1 inlet
    - vacuum and air flow on SVE blower #2 inlet
    - vacuum and air flow on ERH blower inlet
    - pressure and air flow on SVE #1 blower effluent
    - pressure and air flow on SVE #2 blower effluent
    - pressure and air flow on ERH Blower effluent
    - pressure on primary and secondary vapor-phase carbon
    - pressure on stack (following secondary VPGAC)
    - air flow through the stack
    - amperage load on SVE blower #1 motor
    - amperage load on SVE blower #2 motor
    - amperage load on ERH blower motor
    - inlet and outlet temperature on ERH and SVE blowers

TABLE 1
SVE SYSTEM MEASUREMENTS
Blower Test - January 22, 2004

Parameter/Location	Baseline	Test 1	Test 2	Test 2A	Test 3	Test 3A
ERH Flow	711	NM	NM	NM	NM	NM
SVE #1 Influent Flow (cfm)	980	1,555	1,172	1,023	1,009	988
SVE #1 Discharge Flow (cfm)	1,485	1,556	1,127	1,353	1,277	1,292
SVE #2 Influent Flow (cfm)	NM	NM	NM	NM	967	677
SVE #2 Discharge Flow (cfm)	NM	NM	NM	NM	1,369	1,400
Stack Gas Flow (cfm)	2,306	1,567	1,102	1,301	2,680	2,738
SVE 1 Influent Vacuum (inches H_2O)	20	11.9	>100	69.9	63.6	55.4
SVE 1 Discharge Pressure (inches H_2O)	63	31	18	24	78	81
SVE 2 Influent Vacuum (inches H_2O)	NM	NM	NM	NM	23.6	16.5
SVE 2 Discharge Pressure (inches H_2O)	NM	NM	NM	NM	76	80
Pressure on Primary VPGAC (inches of H_2O)	57	26	12	19	69	71
Pressure on Secondary VPGAC (inches of H_2O)	23	20	20	20	>40	>40
Pressure on Stack (inches of H_2O)	24	19	17	18	26.5	28
Amperage load on SVE 1 (amps)	38.6	30.2	49	38.5	50.6	49.6
Amperage load on SVE 2 (amps)	NM	NM	NM	NM	38	38.9

NM = Not Measured

TABLE 2
ERH MEASUREMENTS
Blower Test - January 22, 2004

Parameter/Location	Baseline	Test 1	Test 2	Test 2A	Test 3	Test 3A
ERH Extracted Vapor Velocity (Feet per Minute)	2700	1850	3200	3350	2400	3400
ERH Extracted Vapor Flow (Cubic Feet per Minute)	530	365	630	660	470	670
Well Field Vacuum (Inches of Mercury)	3.5	4	4	4	4	4
Blower Inlet Vacuum (Inches of Mercury)	5.5	5.5	6	6	6	6
Blower Discharge Pressure (Inches of Water)	28	>100	NT	NT	NT	9
Blower Inlet Temperature (^{o} C)	24	19.5	14.5	21	21	20
Blower Outlet Temperature (^{o} C)	79	65.5	32	43.5	46	51.5
Average Blower Amperage Load (Amps)	47.2	33.5	17.8	24.7	25.2	30.8
Electrode D9 Vacuum (Inches of Water)	2	2	2	NT	2	NT
Electrode C11 Vacuum (Inches of Water)	5	5	5	NT	5	NT
Electrode B13 Vacuum (Inches of Water)	9.5	9.5	9.5	NT	9.5	NT
Electrode E15 Vacuum (Inches of Water)	7	6	7	NT	7	NT
Electrode G18D Vacuum (Inches of Water)	3.5	3.5	3.5	NT	3.5	NT
Electrode P16D Vacuum (Inches of Water)	41	41	41	NT	41	NT
Electrode L13 Vacuum (Inches of Water)	34	27	34	NT	41	NT
Electrode M13 Vacuum (Inches of Water)	26	31	27	NT	27	NT
Electrode N11 Vacuum (Inches of Water)	48	48	54	NT	54	NT
Electrode M10 Vacuum (Inches of Water)	48	48	48	NT	48	NT
Electrode N8 Vacuum (Inches of Water)	5.5	5.5	5.5	NT	5.5	NT
Area 1 Branch Header Line 10 Extracted Vapor Flow (Cubic Feet per Minute)	7.5	5.5	8.5	NT	7.5	NT
Area 1 Branch Header Line 16 Extracted Vapor Flow (Cubic Feet per Minute)	13	7.5	20	NT	13	NT
Area 2 Branch Header Line 9 Extracted Vapor Flow (Cubic Feet per Minute)	15	20	11	NT	9	NT
Area 2 Branch Header Line 14 Extracted Vapor Flow (Cubic Feet per Minute)	22	26	21.5	NT	23.5	NT
Area 2 Branch Header Line 17 Extracted Vapor Flow (Cubic Feet per Minute)	5	6	5	NT	5.5	NT

NT = Not Tested

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TABLE 3
SVE WELL MEASUREMENTS
Blower Test - January 22, 2004

SVE Well No.	TEST 1		TEST 3		TEST 3A	
	Vacuum	Flow	Vacuum	Flow	Vacuum	Flow
VE-1	3.5	26	22	52	NM	NM
VE-2	2	5	24	50	15	40
VE-3	2.1	24	18	53	12	44
VE-4	1.7	5	20	48	NM	NM
VE-8	4	0	21	29	NM	NM
VE-9	3	14	20	50	NM	NM
VE-11	1	13	3	27	NM	NM
VE-12	4.1	10	24	45	NM	NM
VE-13	6	9	23.5	47	NM	NM
VE-14	1.9	7	20	51	13	43
VE-15	1.8	4	20	50	NM	NM
VE-17	1.7		3		NM	NM
VE-18	2.2	7	20	47	NM	NM
VE-19	1.9	4	20.5	46	14	36
VE-20	0.9	2	0.9	2	NM	NM
VE-21	0	2	0	2	NM	NM
VE-22	2.2	8	20	46	14	40
VE-23	6	8	24	46	NM	NM
VE-24	4	7	22	51	NM	NM
VE-25	6.3	14	25	50	NM	NM
VE-26	3.8	14	24	52	NM	NM
VE-27	3.8	19	15	>65	11	60
VE-28	1.8	8	18	49	NM	NM
VE-29	4.5	22	23	55	NM	NM
VE-30	1.8	8	9	45	8	39
VE-31	4	16	13	38	11	32
VE-32	2	2	7.5	41	NM	NM
VE-33	0	6	5	47	NM	NM
VE-34	2.1	2	20	45	14	37
VE-35	1.8	19	19	>65	NM	NM
VE-36	2	9	13	42	NM	NM
VE-37	2	5	21	48	NM	NM
VE-38	1	6	13	64	NM	NM
VE-40	4	23	22	52	NM	NM
VE-41	2.3	4	13	43	NM	NM
VE-42	4	21	23	>65	NM	NM
VE-43	2	11	7.5	41	NM	NM
VE-44	2	4	5	30	NM	NM
VE-45	1	8	21	50	NM	NM
VE-46	2.5	2	14	36	NM	NM
VE-47	0	11	16	>65	10	57
VE-48	2.1	13	6	39	5	32

NM = Not Measured